

REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-4, 17-35, 56-58, and 60-67 are pending in the present application. Claims 1, 31, 63, and 65 are amended and Claims 66 and 67 are added by the present amendment.

In the outstanding Office Action, Claim 31 was rejected under 35 U.S.C. § 112, second paragraph; Claims 1-3, 17, 18, and 21 were rejected under 35 U.S.C. § 102(b) as anticipated by Kim et al. ("A Single-Photon Turnstile Device," *Nature*, Vol. 397, page 500, herein "Kim"); Claims 4, 20, and 22-27 were rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Sugiyama et al. (U.S. Patent No. 6,177,684, herein "Sugiyama '684"); Claims 19, 30, and 32 were rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Crow (U.S. Patent No. 5,423,798); Claims 28 and 29 were rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Sugiyama '684 and Cho et al. (U.S. Patent No. 5,314,838, herein "Cho"); Claim 31 was rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Sugiyama '684, Crow, and Cho; Claim 33 was rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Sobolewski et al. (U.S. Patent No. 6,812,464, herein "Sobolewski"); Claim 34 was rejected under 35 U.S.C. § 103(a) as unpatentable over Kim; Claim 56 was rejected under 35 U.S.C. § 103(a) as unpatentable over Kim in view of Sugiyama et al. (U.S. Patent No. 6,281,519, herein "Sugiyama '519"); Claims 57, 58, and 60-62¹ were rejected under 35 U.S.C. § 103(a) as unpatentable over Sugiyama '684 in view of Molotkov et al. ("Quantum cryptography based on quantum dots," JETP Lett., Vol. 63, No. 8, page 687, herein Molotkov); Claim 63 was rejected under 35 U.S.C. § 103(a) as unpatentable over Sugiyama in view of Molotkov and Kim; Claim 64 was rejected under 35 U.S.C. § 103(a) as unpatentable over Stintz (U.S.

¹ It is believed that the outstanding Office Action inadvertently lists Claims 57, 58, and 60-63 instead of Claims 57, 58, and 60-62.

Patent No. 6,816,525) in view of Sobolewski; and Claim 65 was rejected under 35 U.S.C.

§ 103(a) as unpatentable over Stintz in view of Santori (U.S. Patent No. 6,728,281).

Regarding the rejection of Claim 31 under 35 U.S.C. § 112, second paragraph, Claim 31 has been amended to depend from Claim 20, which recites an optic fiber cable, and has also been amended to recite a cavity mode of a mirror cavity. The claim amendments find support in Figure 3 and Claim 22. No new matter has been added. Accordingly, it is respectfully requested this rejection be withdrawn.

Regarding the rejection of Claims 1-3, 17, 18, and 21 under 35 U.S.C. § 102(b) as anticipated by Kim, independent Claim 1 has been amended to recite that a quantum dot is “fully encapsulated between two layers.” The claim amendment finds support in Figure 20 and its corresponding description in the specification. No new matter has been added.

Briefly recapitulating, independent Claim 1 is directed to a photon source that allows emission of a predetermined number of photons at predetermined times. The photon source includes a quantum dot and an electrical supply unit. The quantum dot is fully encapsulated between two layers. In a non-limiting example, Figure 20 shows a quantum dot layer 131 and two layers 133 and 135 that fully encapsulate the quantum dot layer 131 as noted above.

Turning to the applied art, Kim discloses a single-photon turnstile device formed by etching a material to form a plurality of posts, each post having a diameter between 200 and 1,000 nm and a height of a post being approximately 700 nm.² Further, Kim discloses at page 502, first column, first full paragraph, that a surface of the device (plurality of posts) is passivated and encapsulated by silicon nitride film. However, Kim does not teach or suggest that an empty space among the plurality of posts is filled with a material that forms a layer such that the quantum dot is fully encapsulated, as required by amended Claim 1.

² Kim, Figure 1b and its description.

Thus, Applicants respectfully submit that Kim does not teach or suggest the quantum dot being fully encapsulated between two layers, as recited by amended independent Claim 1.

Accordingly, it is respectfully submitted that independent Claim 1 and each of the claims depending therefrom patentably distinguish over Kim.

The outstanding Office Action relies on Kim and Sugiyama '519 for rejecting Claim 56, which recites that the quantum dot is encapsulated between two layers having different lattice constants. Thus, Sugiyama '519 is discussed next regarding amended Claim 1.

Kim shows in Figure 1b a quantum dot structure including a plurality of poles. Kim discloses at page 502, first column, first full paragraph, that:

[p]ost structures with diameters of 200-1,000nm were made by electron-beam lithography followed by metal evaporation, lift-off, and BC_l₃/Cl₂ electron cyclotron resonance plasma etching.

Applicants respectfully submit that etching the edges of the posts is known in the art to introduce dangling bonds that act as non-radiative centers that degrade the efficiency of the quantum dot as a single photon emitter (see specification at page 2, second full paragraph, with regard to the deficiencies of Kim). The device of amended Claim 1 advantageously avoids the above problem of Kim by fully encapsulating the quantum dot between two layers to prevent dangling bonds and the presence of non-radiative centers.

Sugiyama '519 discloses at column 7, lines 26-41, forming a plurality of quantum dots by epitaxially growing layer after layer. However, Sugiyama '519 does not teach or suggest that the method used to produce the plurality of quantum dots within longitudinally extended layers is also capable of forming a plurality of post-type quantum dots as required by Kim. Also, Applicants respectfully submit that there is no motivation or suggestion to use the method of Sugiyama '519 to form the poles of Kim.

As stated in MPEP §2142:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the

references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure.

As discussed above, Applicants respectfully submit the first criterion is not met.

Further, Kim discloses a method for obtaining a single-photon turnstile device that uses pole structures while Sugiyama '519 uses a different method (layered structure) to obtain a plurality of quantum dots. Applicants also note that Sugiyama '684 discloses the same method as Sugiyama '519. Thus, Applicants respectfully submit that one of ordinary skill in the art would not know how to modify the pole structure of Kim based on the layered structure of Sugiyama '519 or Sugiyama '684 to achieve the claimed device.

Accordingly, it is respectfully submitted that combining the teachings of Kim and Sugiyama '519 or Sugiyama '684 would be improper because there is no motivation or suggestion to do so.

Regarding the rejection of Claims 4, 19, 20, 22-34, and 56 under various combinations of Kim, Sugiyama '684, Crow, Cho, Sobolewski, and Sugiyama '519, those rejections are traversed for the following reasons.

The outstanding Office Action relies on Sugiyama '684, Crow, Cho, Sobolewski, and Sugiyama '519 to teach various features not found in the independent claims. However, none of Sugiyama '684, Crow, Cho, Sobolewski, and Sugiyama '519 overcomes the deficiencies of Kim discussed above. In addition, Claims 4, 19, 20, 22-34, and 56 depend from independent Claim 1, which is believed to be allowable as noted above.

Accordingly, it is respectfully submitted that dependent Claims 4, 19, 20, 22-34, and 56 are also allowable.

Regarding the rejection of Claims 57, 58, and 60-62 under 35 U.S.C. § 103(a) as unpatentable over Sugiyama ‘684 in view of Molotkov, that rejection is traversed for the following reasons.

Briefly recapitulating, independent Claim 57 is directed to a photon source configured to allow emission of a predetermined number of photons at predetermined times. The photon source includes a quantum dot and a supply unit that supplies carriers to energy levels of the quantum dot. The supply unit includes a source of pulsed incident radiation that resonantly excites a predetermined number of carriers into the energy levels.

Turning to the applied art, Sugiyama ‘684 is directed to a quantum semiconductor device that includes a plurality of quantum dots 3b formed on a buffer layer 2 in the form of a single layer, as shown in Figure 4A. The outstanding Office Action asserts at page 9, last eight lines, that Sugiyama ‘684 “does not teach supply means in Figure 1” but “it is inherent that said device comprises supply means for supplying carriers to the energy levels.” Thus, the outstanding Office Action relies on Molotkov, which discloses a source of pulsed incident radiation, to modify the device of Sugiyama ‘684.

However, it is noted that Sugiyama ‘684 shows in Figures 6-9 a power supply V that excites carriers in the plurality of quantum dots. Thus, Applicants respectfully submit that Sugiyama ‘684 teaches a power supply unit, and there is no motivation for one of ordinary skill in the art to replace the existent power supply unit of Sugiyama ‘684 with the source of pulsed incident radiation of Molotkov.

In addition, assuming *arguendo* that there is motivation to replace the power supply unit of Sugiyama ‘684 with the source of pulsed incident radiation of Molotkov, it is not clear how one of ordinary skill in the art would use the optical system of Molotkov instead of the electrical system of Sugiyama ‘684.

Therefore, it is respectfully submitted that independent Claim 57 and each of the claims depending therefrom patentably distinguish over Sugiyama '684 and Molotkov, either alone or in combination.

Regarding the rejection of Claim 63 under 35 U.S.C. § 103(a) as unpatentable over Sugiyama '684 in view of Molotkov and Kim, independent Claim 63 has been amended to recite that the supply unit includes (i) a source of “continuous” incident radiation that supplies a carrier, and (ii) a modulating electrical bias unit that vary the transition energies of the quantum dot. The claim amendments find support in the specification at page 32, line 30, to page 33, line 23. No new matter has been added.

Briefly recapitulating, independent Claim 63 is directed to a photon source that is similar to the device of Claim 1 except that the supply unit includes a source of continuous incident radiation for supplying carriers to the energy levels and a modulating electrical bias unit configured to vary a transition energy of the quantum dot.

Thus, the device of Claim 63 allows a single photon to be generated from non-pulsed radiation. This advantage is achieved by modulating the bias across the quantum dot so that the dot is switched between an on-resonance state and an off-resonance state with the non-pulsed incident radiation. When the quantum dot is in the on-resonance state, a predetermined number of carriers are resonantly excited into the energy levels to allow a combination and production of a predetermined number of single photons.

As discussed above, Sugiyama '684 teaches an electrical supply unit although the outstanding Office Action asserts in the paragraph bridging pages 10 and 11 that Sugiyama '684 does not teach a supply unit. In addition, the outstanding Office Action asserts in the same paragraph that it would be obvious to supply a predetermined number of carriers to at least one energy level to allow a recombination of a predetermined number of carriers in the quantum dot to allow the formation of at least one photon, as recited by Claim 63. However,

Sugiyama '684 does not teach or suggest a predetermined number of carriers but on the contrary, a large number of carriers being supplied to a large number of quantum dots.

Molotkov teaches a supply unit which uses incident pulsed radiation to excite carriers. Thus, Applicants respectfully submit that it is not clear why and how one of ordinary skill in the art would combine/replace an optical supply unit as disclosed in Molotkov with an electrical supply unit as disclosed in Sugiyama '684. In addition, the supply unit of Molotkov is based on pulsed radiation while Claim 63 recites a non-pulsed source of incident radiation.

Regarding the modulation unit disclosed by Kim on page 502 and relied upon by the outstanding Office Action, the modulation unit of Kim is used to modulate the number and sign of the carriers within the quantum dot and not the transition energy of the quantum dot as recited by Claim 63. Thus, none of Sugiyama '684, Molotkov, and Kim teaches or suggests a non-pulsed incident radiation.

Accordingly, Applicants respectfully submit that independent Claim 63 patentably distinguishes over the combination of Sugiyama '684, Molotkov, and Kim.

Regarding the rejection of Claim 64 under 35 U.S.C. § 103(a) as unpatentable over Stintz in view of Sobolewski, Applicants respectfully submit that Stintz has a filing date (October 5, 2001) which is later than the filing date (November 16, 2000) of the present application. Therefore, it is respectfully submitted that Stintz is not prior art and the rejection of Claim 64 is moot.

Regarding the rejection of Claim 65 under 35 U.S.C. § 103(a) as unpatentable over Stintz and Santori, Applicants respectfully submit that Stintz is not prior art, as noted above, and Santori is also not prior art because Santori has a filing date (February 9, 2001) which is later than (November 16, 2000) the filing date of the present application. Thus, it is respectfully submitted that this rejection is moot.

New Claims 66 and 67 are added to set forth the invention in a varying scope and Applicants submit the new claims are supported by the originally filed specification. More specifically, new Claims 66 and 67 are similar to Claim 56. No new matter has been added. Further, it is respectfully submitted that new Claims 66 and 67 are allowable as they depend on independent Claims 64 and 65, respectively.

Consequently, in light of the above discussion and in view of the present amendment, the present application is believed to be in condition for allowance and an early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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